TITLE: **MATERIALS SYSTEM FOR INTERMEDIATE TEMPERATURE SOLID OXIDE FUEL CELL**

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1. ABSTRACT

Objectives

The objective of the proposed research is to investigate a materials system for intermediate temperature solid oxide fuel cell that is capable of operating between 600-800^{0}C with a maximum power density greater than 0.5W/cm^2 at 700^{0}C. The electrolyte, anode, and cathode materials in the SOFC system being investigated are Sr and Mg doped lanthanum gallate ($La_{0.9}Sr_{0.1}Ga_{0.8}Mg_{0.2}O_3$ or LSGM), nickel-doped ceria (Ni-$Ce_{0.85}Gd_{0.15}O_2$ or Ni-GDC and Ni-$Ce_{0.6}La_{0.4}O_2$ or Ni-LDC) composites cermets, and LSGM-Sr and Fe doped lanthanum cobaltite (LSGM-$La_{0.6}Sr_{0.4}Co_{0.8}Fe_{0.2}O_3$ or LSGM-LSCF) composites, respectively. These material choices are based on their property information available in the literature.

Accomplishments to Date

Based on the laboratory investigation the desirable materials system for the Intermediate-Temperature Solid Oxide fuel Cell and its structure is determined to be as follows:

(a) Cathode-50% by volume of LSCF-LSGM composite having a fine microstructure (1-2µm grains), porosity of 40-50% and thickness of at least 30-40µm.

(b) Barrier layer-A dense adherent 5µm layer of lanthanum-doped ceria (LDC) must exist between the LSGM electrolyte and the anode to prevent electrolyte-anode interaction.

(c) Electrolyte-20-50 μm thick dense LSGM layer

(d) Anode-50% by volume of Ni-LDC composite having a fine microstructure near the LDC buffer layer and coarser microstructure away from the buffer layer; porosity 40-50%. Since the design is based on an anode-supported cell, the anode can be 1-2 mm thick and the fine microstructure region at least 30-40μm.

LSGM-electrolyte-supported solid oxide fuel cells have been fabricated with the above-mentioned cathode, anode and barrier layer materials. The I-V characteristics and power density of these cells at temperatures between 600-800^{0}C have been determined.

Future Work

1. More LSGM electrolyte supported solid oxide fuel cells will be fabricated with the identified cathode, anode and barrier layer materials and their long-term electrical performance will be evaluated.
2. Anode-supported solid oxide fuel cells will be fabricated with the identified material system and their long-term electrical performance will be evaluated.

List of Paper Published

1. Wenquan Gong, Srikanth Gopalan and Uday B. Pal, “Materials System for Intermediate Temperature (600-800°C) Solid Oxide Fuel Cells (SOFCs) Based on Doped Lanthanum-Gallate Electrolyte.” Submitted to Journal of The Electrochemical Society, December 2004.
2. Wenquan Gong, Srikanth Gopalan and Uday B. Pal, “Cathodic Polarization Study on Doped Lanthanum Gallate Electrolyte Using Impedance Spectroscopy,” Journal of Electroceramics, Vol. 13, December 2004, pp. 653-661.
3. Wenquan Gong, Srikanth Gopalan and Uday B. Pal, “Polarization Study on Doped Lanthanum Gallate Electrolyte Using Impedance Spectroscopy,” Journal of Materials Engineering and Performance, Vol. 13, No. 3, June 2004, pp. 274-281.

Conference Presentations

1. November 2003, "Polarization Studies on Intermediate Temperature Solid Oxide Fuel Cells Based on Lanthanum Gallate Electrolytes", ASM Fall Meeting, Pittsburgh, PA.
2. November 2004, “Materials System for Intermediate Temperature Solid Oxide Fuel Cell”, Materials Research Society Fall Meeting, Boston, MA.

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